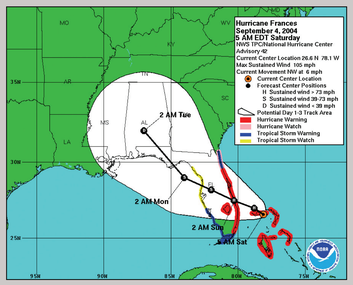
Storm-Related, On-Line Information
for State and Local Coastal Officials

Coastal officials know the importance of time-sensitive, accurate information when it comes to managing the impacts of hurricanes and tropical storms. The Internet hosts valuable information—typically in the form of data, tools, and maps—that can be used for this purpose. This poster highlights some of the more interesting and more useful weather-related Internet resources available today.

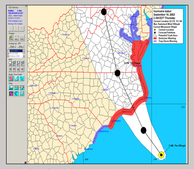
BEFORE



Path Predictions
Forecasts of tropical cyclone positions, as well as the current motion and intensities, are issued at least four times daily by specialists at the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS). Storm positions are given in terms of latitude and longitude coordinates and distance from a selected land point or island. Details on current storm strength include maximum sustained winds in miles per hour and estimated or measured minimum central pressure in millibars and inches. Advisories may be issued every two or three hours when coastal watches or warnings are in effect. Special public advisories may be issued at any time to report significant changes in the storm. These advisories may also contain a list of all current watches and warnings, pertinent weather observations, and information on potential storm tides, rainfall, or tornadoes.

How this information is used
Information about strength of tropical systems and their current and forecast locations is used by myriad officials involved in preparing communities for the onslaught of these "meteorological monsters of the sea." Based on this information, evacuations are planned and initiated, shelters are opened and staffed, and post-storm recovery resource staging is planned.

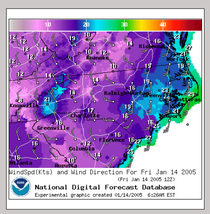
For additional information – *www.nhc.noaa.gov* (current information will be available under Active Tropical Cyclones—June 1 through November 30)



HURREVAC
In 1988, the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers (USACE), and the National Weather Service (NWS) partnered to develop the hurricane evacuation (HURREVAC) model. HURREVAC is a restricted-use computer program used by official government emergency managers to assist in evacuation decision making for their communities. With over 3,500 registered government users in the Atlantic, Caribbean, and Western Pacific regions, it is the primary tool utilized by emergency managers for tracking and responding to tropical systems.

How this information is used
HURREVAC uses information from NOAA's National Hurricane Center, along with customized information from local communities, to track hurricanes and estimate when evacuation decisions should be made. In 2004, the NOAA Coastal Services Center partnered with FEMA, USACE, and the NWS to develop an inland flood planning and response tool to address emergency managers' needs concerning inland flooding. The tool gives users access to real-time flood-related information in textual and graphical formats, such as current rainfall estimates, rainfall forecasts, current and forecasted river stages, general flood alerts, and historical flood impact data.

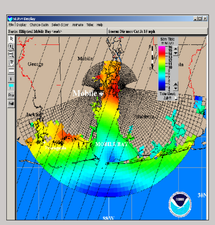
For additional information – *www.hurrevac.com*



Winds
The NOAA National Weather Service provides access to experimental gridded forecast data of wind direction and speed through the National Digital Forecast Database. These data are available in three-hour forecasts through an Internet site. Images and geographic information system data can be created using a tool contained on this site.

How this information is used
Wind speed data are used to estimate the arrival of hurricane force winds in an area, which in turn may impact the timing of evacuations and road closures. The data may also be used to identify locations that experienced the highest wind speeds for post-storm response and assessments.

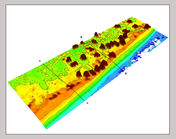
For additional information – *http://weather.gov/forecasts/graphical/sectors/index.php*
http://www.nws.noaa.gov/mdl/NDFD_GRIB2Decoder/



Storm Surge
The greatest potential for loss of life related to a hurricane is from the storm surge, which historically has claimed nine of ten victims. Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. In addition, wind waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. Because much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, the danger from storm tides is tremendous.

How this information is used
Emergency managers use output data from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model to determine which areas must be evacuated for storm surge. Storm surge also affects rivers and inland lakes, potentially increasing the area that must be evacuated. Due to uncertainties in storm movement, operational runs of the SLOSH model are initiated within 24 hours of a storm's expected landfall and continue every six hours or until the threat of rising water subsides. However, hypothetical scenarios using the SLOSH display program can be run earlier for multiple locations.

For additional information
ftp://ftp.nhc.noaa.gov/pub/users/surge (GIS shapefiles and animated gif images will be made available on this ftp site when hurricanes threaten land areas)



High-Resolution Topography
Coastal topography data are used in a variety of ways by state and local coastal resource managers. Light Detection and Ranging (LIDAR) data, for instance, are often used to create images that capture land cover conditions over a large area. This image was created using high-resolution LIDAR and represents the topography that existed on September 27, 1997, along a one-half-kilometer section of beachfront in Rodanthe, North Carolina.

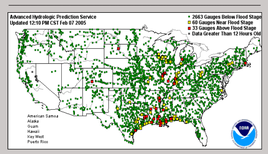
How this information is used
High-resolution topography data can be used to monitor shoreline erosion and accretion and to address issues such as coastal development and resource management. It is also useful for calculating storm surge levels and conducting flood risk analyses.

For additional information
Hurricane-related products: *http://coastal.er.usgs.gov/hurricanes/*
Topography data: *www.csc.noaa.gov/crs/tcm/missions.html*

Tides and Water Levels
Tide and water level information is available from a variety of observation platforms before a tropical cyclone makes landfall. In addition to the NOAA National Data Buoy Center and National Water Level Observation Network, many local tide and water level observation networks exist. These networks have been catalogued by various organizations and agencies, such as NOAA's nowCOAST Internet mapping Web site.

How this information is used
Tide and water level information can be used to determine potential storm surge and wave heights for locations in the path of a storm. Knowing when and where to expect abnormal conditions can help determine when advisories and evacuations should be issued.

For additional information
NOAA's nowCOAST: *http://nowcoast.noaa.gov/viewer.htm*
NOAA National Data Buoy Center: *www.ndbc.noaa.gov*
National Ocean Service Water Level Observation Network: *www.co-ops.nos.noaa.gov/usmap.html*



Flood Predictions
In the last 30 years, inland flooding has been responsible for more than half the deaths associated with tropical cyclones in the United States. Inland flooding can be a major threat to communities hundreds of miles from the coast as intense rainfalls develop from these huge tropical air masses. The NOAA National Weather Service has the mission of providing flood predictions for both flash flooding and river flooding. Predictions of how high the water will rise can save lives and property, and help maintain economic vitality.

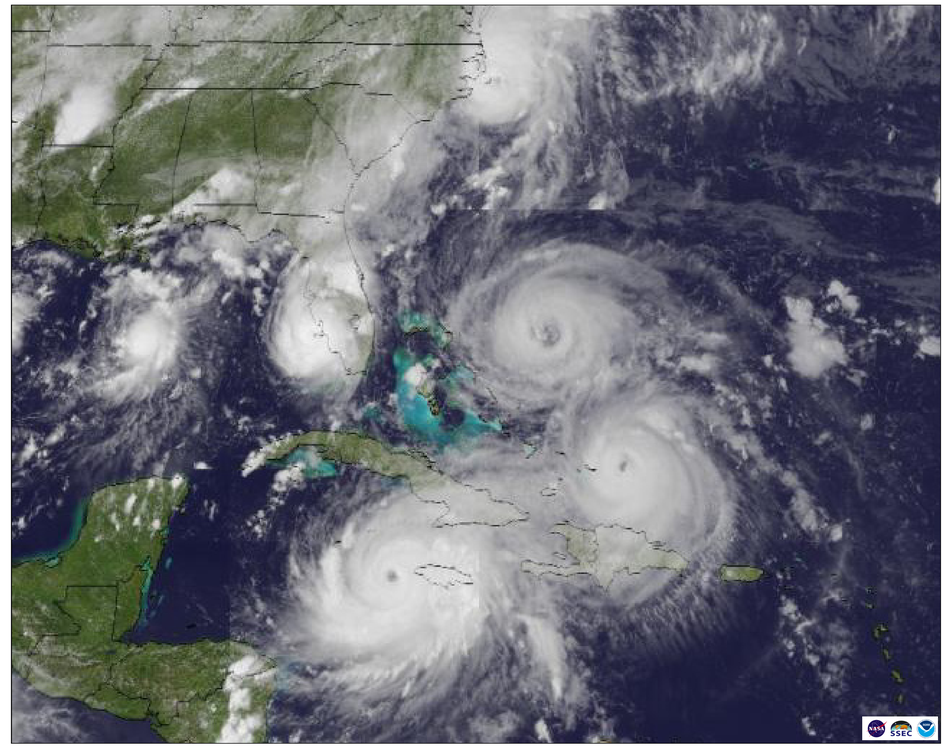
How this information is used
New data sources are making it easier to identify potential flooding problems in advance of an event. This information is then used to make important decisions regarding evacuations, property protections, and water resource management.

For additional information
Flood forecasts: *www.nws.noaa.gov/rivers_tab.php*
Flash flood guidance: *www.srh.noaa.gov/rfcshare/ffg.php?duration=3&location=NAT*
National significant flood outlook: *www.hpc.ncep.noaa.gov/nationalfloodoutlook/*
Map of flood and high flow conditions: *http://water.usgs.gov/cgi-bin/dailyMainW?state=us&map_type=flood&web_type=map/*

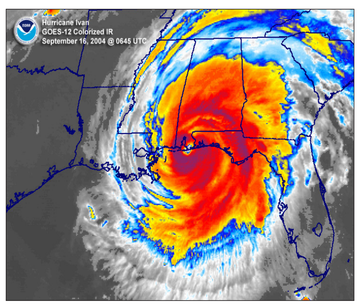
New Products under Development
GLIMO – Enhanced Resiliency of Coastal Communities to Storm Surge and Flooding through Improved Data, Models, Tools, and Methodologies
The vision of the NOAA National Ocean Service (NOS) is to be the Global Leader in Integrated Management of the Ocean (GLIMO). NOS will meet this challenge through five themes—observations, modeling, watersheds, partnerships, and technology. Under the auspices of GLIMO, NOS is working with multiple partners to enhance the resiliency of Gulf of Mexico (GOMEX) coastal communities to coastal storm impacts. This project will address the following: improved topographic, bathymetric, gravimetric, and geodetic data; storm surge forecasting and warning systems; decision-support tools used for evacuation strategies; planning and risk and vulnerability assessment methodologies; improved capabilities for working with digital elevation, water level, and geodetic data; enhanced ecosystem protection and change analysis, post-hurricane damage assessment, updated national shoreline, and sea-level rise modeling; and information systems designed for response and restoration activities.

This project is being developed in conjunction with related activities in the GOMEX region such as the NOAA assessment of existing and needed storm surge prediction and response capabilities, the Southeastern Universities Research Association (SURA) Coastal Ocean Observing and Prediction (SCOOP) program, and ongoing development of Integrated Ocean Observing System (IOOS) Regional Associations. Developing and demonstrating the value of enhanced ocean observing systems to coastal communities in the GOMEX region through this pilot project, and through data integration and visualization projects such as the *www.openioos.org/ portal/*, will help guide NOAA and others in defining future requirements for regional and coastal ocean observing systems.

For additional information – *www.oceanservice.noaa.gov/about/GLIMO/welcome.html*



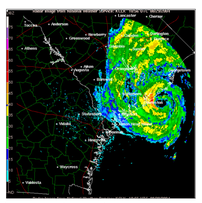
DURING



Satellites
The National Oceanic and Atmospheric Administration (NOAA) uses a variety of different satellite sensors to obtain both qualitative and quantitative information on environmental conditions before, during, and after hurricanes. Satellite data are critical across the large expanse of ocean where airborne sensors are impractical or impossible.

How this information is used
The various sensors provide timely temperature and water vapor measurements throughout the atmosphere that are important parameters in the modeling of hurricane trajectories. Coastal managers can use satellite imagery to monitor changes in the movement and structure of hurricanes, both primary indicators of a storm's potential effect on a given area.

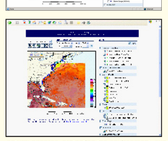
For additional information
NOAA Geostationary Satellite Server: *www.goes.noaa.gov/g8hu.html*
NOAA Environmental Visualization: *www.nnvl.noaa.gov*
Naval Research Laboratory (NRL) Monterey Marine Meteorological Division's Tropical Cyclone Page: *www.nrlmry.navy.mil/tc_pages/tc_home.html*
Moderate Resolution Imaging Spectroradiometer (MODIS) Rapid Response System: *http://rapidfire.sci.gsfc.nasa.gov/realtime/*



Local Radar
Along with many other tools, NOAA's National Weather Service uses NEXRAD (Next Generation Radar) to track and monitor severe weather, such as hurricanes and tropical storms, particularly when these systems near the coast. The monitoring network gives forecasters detailed information on hurricane wind fields, rain intensity, and storm movement.

How this information is used
Forecasters can pick out details about storm features (such as the locations of the eye and rain bands), storm motion, and intensity. Other radar products, such as radial wind velocity, give forecasters important information about wind speed and direction. These tools allow forecasters to provide much more timely and accurate warnings than were possible only a few years ago. This information enables forecasters in local weather service offices to issue short-term warnings for floods, tornadoes, and high winds for specific areas.

For additional information – *www.nws.noaa.gov/radar/*

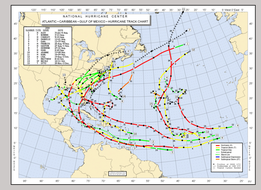


New Products under Development
Ocean Observing Systems
An important component of any hurricane-related tool or Web site is data that are accurate, reliable, and easy to use. Buoys, satellites, and other remote sensing technology are bringing new sources of ocean-related data to forecasters and other coastal officials. The ocean observing system is envisioned as a network that systematically acquires and disseminates data and information to serve the needs of many user groups (government agencies, industries, scientists, educators, nongovernmental organizations, and the public).

How this information is used
Recent studies demonstrate that the economic benefits of investing in ocean observations to improve weather and climate forecasts can be substantial. Weather and climate predictions can be greatly improved with better ocean measurements of other basin-scale processes (e.g., the North Atlantic Oscillation and the North Pacific Decadal Oscillation). With improved predictions come economic benefits, not only pertaining to agriculture and power generation, but also to mitigating the impacts of natural hazards, protecting the environment, sustaining living resources, and managing coastal zones.

For additional information – *www.ocean.us*

AFTER



Track Analysis – Best Track
Archived tropical cyclone tracks are referred to as "best tracks." These are constructed using careful post-analysis techniques. All available information is used, including radar and satellite imagery, aircraft reconnaissance fixes, ship reports, station reports, and ocean data buoy reports. Best track data are published annually and are typically made available several months following the conclusion of the hurricane season.

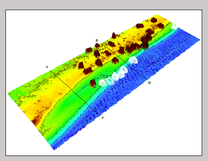
How this information is used
Historical tropical cyclone data are used in a variety of ways. Forecasters use these data to develop models to predict the course of future storms. Coastal planners use these data to formulate "return periods" in an attempt to determine what areas of the coastline are likely to experience the most strikes from future storms. Insurance companies and financial institutions use these data to determine insurance premiums for coastal residents.

For additional information
http://hurricane.csc.noaa.gov/hurricanes/index.htm
www.nhc.noaa.gov/pastall.shtml

Shoreline Change
Coastal changes, such as the erosion of beaches, dunes, and sea cliffs, can pose significant hazards to buildings and infrastructure. New data sources, models, and tools help coastal communities predict how much coastal change will occur during extreme storms and normal weather patterns. These tools include Light Detection and Ranging (LIDAR), oblique aerial video and photography, and ground surveys.

How this information is used
LIDAR is used to analyze sand dune volumes and calculate changes. Aerial video and photography is often used to determine the amount of damage and overwash that occur during a storm event. Ground surveys of beach elevation are used to ground truth LIDAR data and verify and enhance predictive models and flood forecasts. State and local officials use this information to create setback zones and move buildings and infrastructure away from coastal change hazards.

For additional information
Coastal and marine geology program Internet map server: *http://coastalmap.marine.usgs.gov*
Hurricane and extreme storm impact studies: *http://coastal.er.usgs.gov/hurricanes/*
Coastal change hazard scale: *http://coastal.er.usgs.gov/hurricanes/mappingchange/scale.html*



High-Resolution Topography
This image represents the LIDAR-derived topography that existed on September 9, 1999 (after Hurricane Dennis), along the same one-half-kilometer section of beachfront in Rodanthe, North Carolina, that is shown in the "before" section of this poster. Note the new position and shape of the shoreline, the altered dune morphology, and the loss of seven houses.

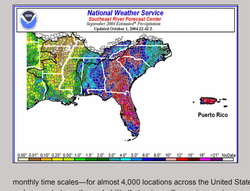
How this information is used
High-resolution topography data can be used to monitor shoreline erosion and accretion and address coastal development and resource management issues. It is also useful for calculating storm surge levels and flood risk analysis.

For additional information
Hurricane-related products: *http://coastal.er.usgs.gov/hurricanes/*
Topography data: *www.csc.noaa.gov/crs/tcm/missions.html*

Environmental Effects
The National Oceanic and Atmospheric Administration's (NOAA) Office of Response and Restoration helps officials respond to toxic chemical spills. These tools include Environmental Sensitivity Index (ESI) maps and software packages for oil spill responders and planners, as well as data, maps, databases, information about historical events, and case studies.

How this information is used
If a facility that produces or houses toxic chemicals or oil is damaged or destroyed by a coastal storm, the aforementioned products can help officials locate sensitive species or environments, provide instructions on how to clean up toxic chemicals, and supply other maps and databases that are helpful for recovery efforts. The case studies with lessons learned information are invaluable tools for communities looking to implement or improve a hazardous response program.

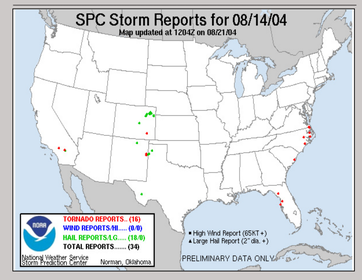
For additional information – *http://response.restoration.noaa.gov*



Precipitation and Flood Analysis
In an average year in the United States, inland flooding is the cause of an estimated 133 lost lives and property damage that exceeds $4 billion. The NOAA National Weather Service's Advanced Hydrologic Prediction Services (AHPS) Web site provides a variety of information resources and tools designed to lessen these impacts. The site displays forecasts of flooding or drought magnitude and uncertainty—in hourly, daily, and monthly time scales—for almost 4,000 locations across the United States. These forecasts target rivers and concentrate on the probability that a river will experience minor, moderate, or major flooding; estimate the chance of a river exceeding a certain level, volume, and flow of water at specific points on the river during 90-day periods; and provide a map of areas surrounding the forecast point with information about major roads, railways, and landmarks likely to be flooded, as well as the levels of past floods.

How this information is used
Flood forecast products help people make informed decisions about risk-based policies and actions to mitigate the dangers posed by floods and droughts. Emergency management officials at local and state levels use these forecasts to fight floods and evacuate residents. The historical and predictive information is also helpful to those deciding where to develop land along the coast and to take other measures to mitigate the impacts of flooding.

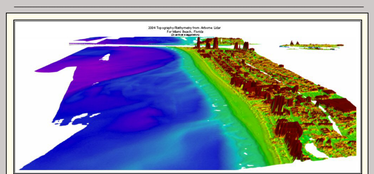
For additional information
Data for the National Weather Service Southern Region (North Carolina to Texas):
www.srh.noaa.gov/rfcshare/precip_analysis.php
River Forecast Centers and real-time river gage information: *www.crh.noaa.gov/ahps/rfc.php*



Damage Assessment and Post-Storm Impact Data
Documenting events and information related to a major weather event is an important part of NOAA's effort to improve this nation's response and preparedness. These reports can include information about the life history and effects of a tropical cyclone; the before, during, and after actions of NOAA offices, such as the National Weather Service; recommendations for changes in organizational procedures, products, and services; post-storm impacts, warning and forecast services; tools and models used; damage assessment figures; climatology data; lessons learned (findings and results); evacuation results; and other data and information.

How this information is used
In addition to helping NOAA determine the accuracy of its forecasts and the effectiveness of its organization, these reports provide damage and casualty statistics (insured property damage amounts, deaths, injuries, total damage dollar amounts, geographic areas impacted), summarize major economic impacts, and offer reports on types of damage (wind, flood, etc.). This information can assist in targeting areas for damage assessment teams and response activities, test and assess model outputs, and identify geographic areas for future mitigation projects.

For additional information
National Hurricane Center products from past seasons: www.nhc.noaa.gov/pastall.shtml
Significant event service assessments from the National Weather Service: *www.nws.noaa.gov/om/assessments/index.shtml*
Storm reports from the Storm Prediction Center: www.spc.noaa.gov/climo/



New Products under Development
Topobathy
This image represents combined topography and bathymetry (topobathy) data along a section of Miami Beach, Florida. The LIDAR-derived data were collected by the U.S. Army Corps of Engineers' Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) using the Compact Hydrographic Airborne Rapid Total Survey (CHARTS) system. The survey generally extends 750 meters inland and up to 1,500 meters over the water (depending on water depth and clarity).

How this information is used
Recently developed methods for collecting high-resolution topobathy data sets provide more complete and accurate representations of the coastal zone than separate topography and bathymetry data sets. These comprehensive data sets are collected quickly and cost-effectively, and provide excellent spatial coverage along coastal margins. Site characterizations, change analyses, and hydrographic models are more informative and accurate using combined topobathy data sets.

For additional information
JALBTCX and topobathy sensors: http://shoals.sam.usace.army.mil/default.htm
Topobathy data: *www.csc.noaa.gov/crs/tcm/missions.html*

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

For additional copies of this poster, visit *www.csc.noaa.gov/clearinghouse/*